Summary of the Chemicals of Concern Found in Fish: San Francisco Bay Pilot Study, 1994

In 1994 the San Francisco Bay Regional Water Quality Control Board conducted a pilot study to find out what levels of chemicals are present in sport fish in San Francisco Bay. The study was done to guide pollution control activities by determining what types of chemicals are present and where high concentrations may be occurring. It will also identify what further studies are needed. The pilot study was expanded to provide enough information to perform a preliminary health risk assessment on consuming certain fish species caught in the bay. A health advisory for striped bass had already been in effect for many years based on elevated levels of methylmercury, an organic mercury compound frequently found in fish. The study was thus also intended to determine whether more health advisories should be issued for other fish species that might be contaminated.

The fish in the pilot study were analyzed for about 100 chemicals. Methylmercury and five other chemicals or chemical groups were found to be at levels that were considered high enough to need more investigation. These chemicals include the chlorinated compounds PCBs, dioxins, chlordane, the DDT group, and dieldrin. They are generally associated with industrial activities or agriculture whereas mercury comes from natural and industrial sources. Once these chemicals are released into the environment, they stay there for many years and may be taken up by fish.

The Office of Environmental Health Hazard Assessment (OEHHA) evaluated the potential health hazard of eating fish containing these chemicals. We found that the levels of PCBs, methylmercury, and to a lesser extent dioxins pose a potential health hazard. Eating a few meals of bay sport fish will not make people sick. Our concern is for the potential long-term effects of eating chemically contaminated fish, and especially the potential for harm to sensitive groups such as children and developing young. We issued an interim advisory recommending that people limit the amount of sport fish they consume from the bay. We also recommended preparation and cooking methods to remove some of the chemicals in the fish.

Because some anglers and their families may be concerned about the potential health effects of the chemicals in this study, we prepared this summary of the six main chemicals named in the study. We report acute toxicity (effects after a single large dose) and chronic toxicity (effects from small exposures over a long time). It is important to understand, however, that the health effects described here often result from much greater exposures than what someone might get from eating sport fish from the bay. The effects described here often result from the high doses given to animals in laboratory tests, rather than exposures to these chemicals in fish. If you are exposed to hazardous chemicals, many factors or circumstances will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), and the other chemicals to which you are exposed. Your individual characteristics such as age, sex, nutritional status, family traits, life style, and state of health are also important factors.

When we developed our interim health advisory for bay sport fish, we took into account as many of these factors as possible. Following the advisory's guidelines will reduce your exposure to harmful chemicals and protect you against harmful effects.

For more information about the health advisories on eating sport fish in California, contact OEHHA, as listed the end of this document. We have prepared other materials on PCBs and methylmercury in fish, which will help explain these chemicals. A summary of the San Francisco Bay study and an illustrated brochure on ways to protect your health when you sport fish are also available.

PCBs (Polychlorinated Biphenyls)

PCBs are mixtures of related chemicals that were sold under the trade name of Aroclor. They were used as transformer fluids, lubricants, hydraulic fluids, and similar products. Their production and use have been banned since 1979. However, these chemicals are still common in the environment where they last a long time and build up in animal tissues. PCBs can be stored in body fat and secreted in milk. The forms with the most chlorine in them tend to last the longest in the environment and in the body. All PCB mixtures change over time. Thus, the PCB mixtures found in the environment are never the same as the products that were actually used. They also differ from the forms used in studies of health effects. These differences complicate evaluation of toxicity.

PCBs are not highly toxic with a single dose. However, there is concern that continued low levels of exposure may be harmful. Effects on the kidneys and the circulatory, digestive, nervous, and immune systems have been seen in animal tests. Effects were also found in children of mothers who ate fish from the Great Lakes. These fish had large amounts of PCBs. In these children, small head size, reduced visual recognition, and delayed muscle development were reported. Young children may be especially vulnerable to PCBs because of the greater sensitivity of their developing nervous systems. Some PCB mixtures have been shown to cause cancer in animal studies. It is not clear whether similar effects will occur from low levels of PCBs in people. The U.S. EPA rates PCBs as "probable human carcinogens" because they have been shown to cause cancer in animals and are, therefore, presumed to cause cancer in humans. They are also listed under California's Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65). This act regulates the discharge into waterways of chemicals that are known to cause cancer or reproductive harm in humans or animals.

Dioxins

Dioxins are also mixtures of chemicals, somewhat similar to PCBs. Dioxins have never had an industrial use. They come from chemical reactions in industrial processes and from incineration of chemicals containing chlorine. Forest fires can produce dioxins, but most of the environmental contamination is believed to be from human activities. The most hazardous form of dioxin is TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin), often called simply dioxin. It is a trace component of environmental dioxin mixtures. Dioxins, like PCBs, stay in the environment for a long time. They build up in the food chain, especially in fatty tissues.

Dioxins have been shown to be extremely toxic in laboratory animal studies. They affect multiple organ systems. Reproductive and developmental effects, cancer, and damage to the immune system have been seen in animal studies. TCDD has the highest cancer potency ever found in animal tests. In animal studies, its toxicity to the reproductive and immune systems also occurs at very low doses.

In humans, exposure to dioxin in the workplace has produced chloracne, a severe skin rash. Although no other human diseases have been clearly linked to dioxin exposure, there is concern that dioxins could produce adverse effects in humans similar to those seen in laboratory animal studies. TCDD is considered a probable human carcinogen by U.S. EPA and is listed under Proposition 65.

U.S. EPA is currently conducting a dioxin review. In the draft study released in 1994 for public review and comment, U.S. EPA suggested that total dioxin exposures may already be at a level of concern in some people. However, environmental dioxin levels appear to be decreasing. Improved controls and changes in manufacturing processes have been put in place. Therefore, the long-term situation is improving.

Chlordane
This is another long-lasting organochlorine chemical. It was used as a pesticide, particularly for termite control in homes. Most uses were banned in 1988. It is still found at significant levels in fish and in fatty tissues of animals and people. Significant levels are also often found in soil around the foundations of homes.

Acute exposure to chlordane affects the nervous system and, at very high doses, causes convulsions. Chronic exposures to chlordane can damage the liver and nervous systems. Such effects have been seen in people who were chlordane applicators. Similar effects were also seen in some people exposed to excessive levels of chlordane in the home.

Animal studies show that prenatal exposure can cause damage to the developing nervous and immune systems. Therefore, fetuses and children may be at greater risk than adults from chlordane exposure. Also, because chlordane accumulates in body tissues, and can be passed through breast milk, children and women with childbearing potential should be especially careful to reduce their exposure to chlordane.

Increased tumor rates were reported in several animal studies. In humans, brain tumors and leukemia have been associated with prenatal and early childhood exposures in several studies. Chlordane is rated as a probable human carcinogen by U.S. EPA and is listed under Proposition 65.

The DDT Family (DDT, DDD, and DDE)
DDT (dichlorodiphenyltrichloroethane) was banned as a pesticide in the U.S. in 1972. Human exposure to DDT from general food sources was about 100 times higher during peak use in the early 1970s than it is now. Due to its extreme persistence, however, DDT

residues, including DDD and DDE, still remain in the environment and may be found in fish at potentially harmful levels.

DDT has moderate to low acute toxicity. DDD and DDE have similar effects and are usually combined with DDT for hazard estimates. Low-dose chronic exposure in animals can cause liver damage and disrupt the reproductive and immune systems. Some studies suggest that DDT exposure can result in chromosomal damage, leukemia, and lung cancer in humans. DDT is also suspected of causing spontaneous abortion and premature births in humans. Children may be at more risk than adults because of effects on the developing nervous system. Exposure levels that were thought to be safe may be reconsidered because of new findings on developmental, reproductive, and immune effects, according to a recent U.S. EPA review. DDT and DDE are considered to be probable human carcinogens by U.S. EPA and are listed under Proposition 65. However, their potential cancer potency is relatively low. Attention has recently focused more on their hormonal and reproductive effects.

Dieldrin

This is another of the older organic pesticides. Its use was slowly phased out in the U.S. between 1974 and 1987. However, dieldrin is still found in soils and sediments because it is a very stable chemical. It also remains for a long time in animal tissues where it builds up in fat. Dieldrin can potentially be very toxic to fish. Dieldrin also comes from the breakdown of aldrin, another banned pesticide.

In humans, acute exposure can cause excess excitability, tremors, convulsions, and liver changes. Liver damage also occurs from chronic exposure. Nervous system changes are also seen in people exposed over a long time. Defects in the developing fetus were reported in animals given very low doses. Dieldrin is considered a probable human carcinogen by U.S. EPA and is listed under Proposition 65. The cancer effect is potent. However, many scientists think it is secondary to dieldrin's strong effects on the liver.

Methylmercury

This organic chemical forms in sediments and in animal tissues from metallic mercury or its salts. Mercury ores are found naturally in several places in northern California. Much of the mercury in waterways is related to past mining activities. Methylmercury builds up in fish, other animals, and in humans. It reacts with proteins and stays in the tissues. Trimming fat from fish will not lower exposure to this chemical as it will for other chemicals.

Methylmercury concentrates in human kidneys. High levels may lead to kidney or circulatory failure. However, damage to the central nervous system can occur at much lower doses after long-term exposure. Tremors, incoordination, and weakness are prominent effects. Very low doses in humans can cause numbness or tingling in the hands or feet. The fetus, infants, and children may be especially sensitive to methylmercury's effects on the nervous system. Problems with mental development and coordination are seen in children of women exposed before and during pregnancy. Methylmercury is listed under Proposition 65 due to its reproductive toxicity.

For More Information
To obtain additional information, contact:

Pesticide and Environmental Toxicology Section (PETS) of the Office of Environmental Health Hazard Assessment (OEHHA)
1515 Clay St.
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Oakland, CA 94612
(510) 622-3170
(510) 622-3218 FAX

or the Sacramento office:

Pesticide and Environmental Toxicology Section (PETS) of the Office of Environmental Health Hazard Assessment (OEHHA)
1001 I Street, P.O. Box 4010
Sacramento, CA 95812
(916) 324-7572
(916) 327-1097 FAX

To obtain a copy of the San Francisco Bay Study, entitled, Contaminant Levels in Fish Tissue from San Francisco Bay, contact:

San Francisco Bay Regional Water Quality Control Board
2101 Webster Street, Suite 500
Oakland, CA 94612
(510) 286-1255.